Effect of sowing time x seed rate x herbicides on ryegrass management in barley (Roseworthy, SA)

Abstract

In this field trial in barley at Roseworthy, SA, combinations of time of sowing, seed rate and herbicide treatments were used to study annual ryegrass management. Ryegrass plant density in barley was only significantly affected by the herbicide treatments ($P<0.001$). Even though the difference between the herbicide treatments was highly significant, Treflan and Boxer Gold treatments only reduced ryegrass plant density compared to the control by 26% and 33%, respectively. This lower than expected weed kill by Boxer Gold is likely to be associated with dry soil conditions due to below average rainfall at Roseworthy. Barley grain yield as significantly influenced by the time of sowing ($P=0.025$), seed rate ($P<0.001$) and the herbicide treatment ($P<0.001$). The delay of 4 weeks between the two sowing dates caused 22% (0.69 t/ha) reduction in grain yield or 25 kg/ha/day. Averaged over the two sowing dates and three seed rates, Boxer Gold treatment (2.996 t/ha) produced significantly greater barley grain yield than Treflan (2.634 t/ha) and the control (2.648 t/ha). Barley sown early (TOS 1) at high seed rate and sprayed with Boxer Gold produced 3.6 t/ha grain yield as compared to later sown crop (TOS 2) at low seed rate but treated with the same herbicide which produced 2.4 t/ha.

Introduction

Even though most of the Australian research on cultural weed management has been done with wheat, previous studies have largely investigated single tactics and not their combinations. Change in sowing time can have multiple effects on crop-weed competition. Delayed sowing can provide opportunities to kill greater proportion of weed seedbank before seeding the crop but weeds that establish in late sown crops can be more competitive on per plant basis.

Crop density is an important non-chemical weed management tactic especially in wheat. Farmers are usually reluctant to increase barley seed rate too much due to increased risk of foliar diseases. Crop seed rate is an easy tactic for the growers to change during their seeding program provided they are convinced of its benefits to weed management.

As annual ryegrass has developed resistance to all post-emergent selective herbicides, its management in cereals is now largely based on pre-emergent herbicides such as Boxer Gold and Treflan. This trial aims to investigate the impact of integration of sowing time and seed rate of barley with pre-emergent herbicides on ryegrass density and seed production as well as on barley grain yield.

Methods

Trial site: Roseworthy

This field trial investigated combinations of the following management tactics (refer to Table 1 for details).

1. **Sowing time (2)**: early May and early June
2. **Seed rate (3)**: 1x (200 seeds/m^2), 0.75x (150 seeds/m^2), 0.5x (100 seeds/m^2)
3. **Herbicides for ryegrass trials (3)**:
   (i) Control (pre-sowing glyphosate treatment only)
   (ii) Treflan 2 L/ha (480 g/L) IBS
   (iii) Boxer Gold 2.5 L/ha IBS

Variety: Spartacus

Trial design: split-split plot design

Replicates: 3

Trial Management

Table 1. Key management operations undertaken.

Operation	**Details**
Seedbank soil cores	24 April, 2018
Sowing date	TOS 1: 21 May, 2018 TOS 2: 19 June, 2018
Fertiliser at sowing	Diammonium phosphate + zinc + @ 100 kg/ha
In-crop fertiliser application	Urea @ 100 kg/ha at GS30
Herbicide treatments	21 May, 2018 and 19 June, 2018 (applied just before seeding) Control (pre-sowing glyphosate treatment only) Treflan 2 L/ha (480 g/L) IBS (incorporated by seeding) Boxer Gold 2.5 L/ha IBS

All data collected during the growing season was analysed using the Analysis of Variance function in GenStat version 15.0.

Roseworthy experienced a below-average rainfall growing season in 2018. Most of the months in 2018 received rainfall well below the long-term average (Table 2). However, rainfall in May was close to the average and August rainfall was well above the long-term average. Spring rainfall (Sep-Oct) was also below the long-term average for the area.

Table 2. Rainfall received at Roseworthy in 2018 and the long-term average.

Month	**Rain (mm)**	
	2018	**Long-term average**
Jan	12.2	18.1
Feb	5.0	20.4
Mar	7.2	18.5
Apr	18.4	31.8
May	36.6	38.0
Jun	33.8	45.1
Jul	22.0	44.4
Aug	59.2	46.4
Sep	17.2	47.0
Oct	13.4	30.9
Nov	45.6	26.2
Dec	23.2	26.5
Annual total	293.8	393.3
Growing season	200.6	283.6

Results and Discussion

Barley plant density

Barley plant density was significantly influenced by crop seed rate (P<0.001). At the same seed rate, barley plant density was 16 to 23% higher in the time of sowing 1 (TOS 1). Higher soil moisture after sowing in TOS 1 than in TOS 2 may have caused this difference in barley establishment. Below average rainfall at Roseworthy during May, June and July in 2018 is likely to be the main cause of reduced crop establishment. There was also a significant effect of the herbicide treatment on barley plant density (P=0.017), which was associated with 11% reduction in the Treflan treatment compared to the nil herbicide control and Boxer Gold.

Ryegrass seedbank, plant and spike density

Ryegrass seedbank at the trial site was high and uniform. The seedbank for the 3 replicates ranged from 11,708 to 14,673 seeds/m^2 with an average of 12,866 ± 1264 seeds/m^2. Ryegrass plant density in barley was only significantly affected by the herbicide treatments (P<0.001). Even though the difference between the herbicide treatments was highly significant, Treflan and Boxer Gold treatments only reduced ryegrass plant density compared to the control by 26% and 33%, respectively. It is well known that dry seed-bed conditions reduce absorption of pre-emergent herbicides by the weed seedlings and this reduced herbicide efficacy. However, such low levels of weed control by pre-emergent herbicides on ryegrass populations with multiple herbicide resistance could lead to population build-up and cause management difficulties in subsequent years.

Ryegrass spike density was significantly influenced by the time of sowing (P=0.027), crop seed rate (P=0.013) and the herbicide treatment (P=0.007). However, there was no interaction between these management factors. When averaged across seed rates and herbicide treatments, barley sown later (TOS 2) had 58% greater number of ryegrass spikes than TOS 1 (310 vs 490 spikes/m^2). As there was no effect of time of sowing on ryegrass plant density, this difference in spike density between the two sowing dates appears to be entirely due to reduced competitive ability of later sown barley. Greater spike density of ryegrass in TOS 2 is most likely related to significantly lower barley plant density.

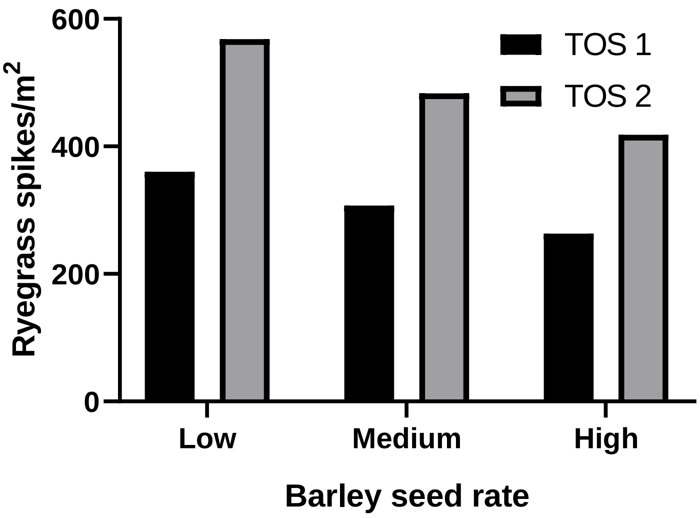

Figure 1. The effect of barley seed rate on ryegrass spike density

Herbicide treatments used in barley also had a significant effect on ryegrass spike density (P=0.007; Figure 2). Even though the response to pre-emergent herbicides was statistically significant, the level of reduction achieved even by Boxer Gold was only 29%. As mentioned earlier, extremely dry soil conditions for the first 2 months after sowing appears to have had a dramatic effect on herbicide performance in this trial. Resistance to trifluralin has been previously confirmed in some paddocks on the farm. Therefore, poor efficacy of Treflan was not surprising but low efficacy of Boxer Gold was completely unexpected.

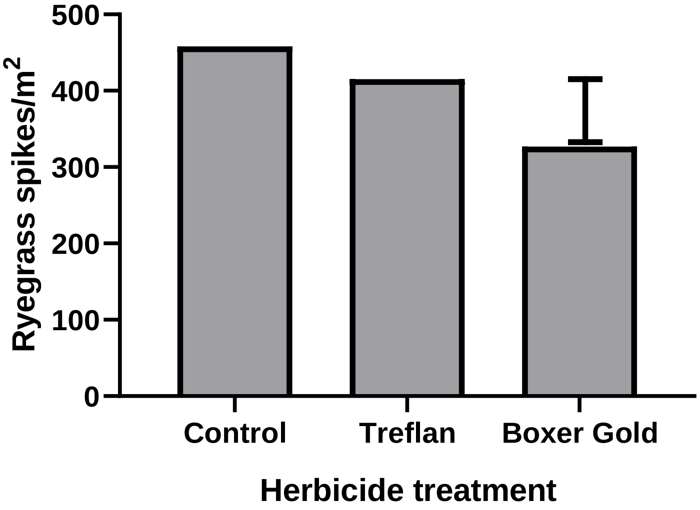

Figure 2. The effect of herbicide treatments used in barley on ryegrass spike density. The vertical bar represents LSD (P=0.05).

Ryegrass seed production

Delay in sowing barley from 21 May to 19 June (4 weeks) increased ryegrass seed production by 55% (P=0.01). Some of this effect could be due to lower barley establishment in TOS 2 but reduced competitive ability of late sown barley also appears to be an important factor (Figure 3). When averaged across the seed rates and herbicide treatments, ARG produced 9739 seeds/m^2 in TOS 1 as compared to 21731 seeds/m^2 in TOS 2. There is some evidence that ARG become more competitive with crops under colder winter conditions than in warmer autumn conditions. Superior competitive ability of ryegrass in later sown crops is further supported by greater seed production in TOS 2 (44 seeds/spike) than in TOS 1 (31 seeds/spike) (P=0.02).

Barley seed rate also had a significant effect on ryegrass seed production (P=0.021). When averaged across the times of sowing and herbicide treatments, increase in seed rate from low (target 100 plants) to high (200 plants/m^2) reduced ryegrass seed production by 33% (18987 Vs 12622 seeds/m^2) (Figure 4). As expected, herbicide treatments had a significant effect on ryegrass seed production (P=0.012). This was reflected in a significant reduction is ryegrass seed production by Boxer Gold compared to the untreated control. Extremely dry soil conditions for the first 2 months after sowing appears to have had a dramatic effect on herbicide performance in this trial. Even though there was no interaction between the time of sowing, seed rate and herbicide treatment, it is instructive to look at the highest and lowest seed production of ryegrass. The highest seed production by ryegrass occurred in TOS 2-low seed rate-untreated control (31,316 seeds/m^2). In contrast, the lowest seed production of ryegrass was found in TOS 1-high seed rate-Boxer Gold (4788 seeds/m^2). In other words, integration of early sowing with high seed rate and a suitable herbicide was able to reduce ryegrass seed production by 85% even in a very dry season which was not conducive for the performance of pre-emergence herbicides.

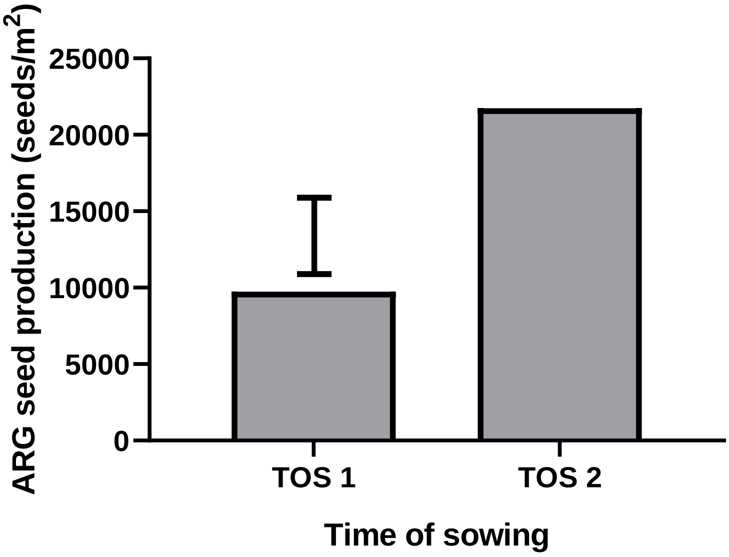

Figure 3. The effect of time of sowing barley (averaged across seed rates and herbicides) on ryegrass seed production. The vertical bar represents LSD (P=0.05).

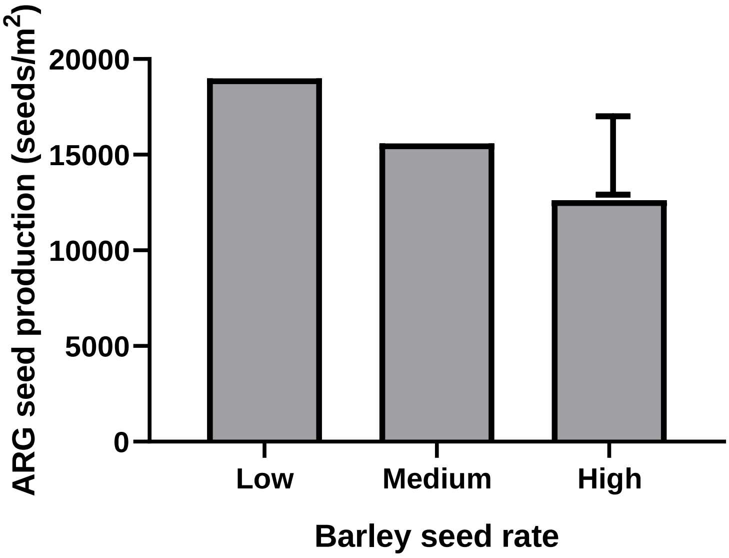

Figure 4. The effect of barley seed rate (averaged across sowing times and herbicides) on ryegrass seed production. The vertical bar represents LSD (P=0.05).

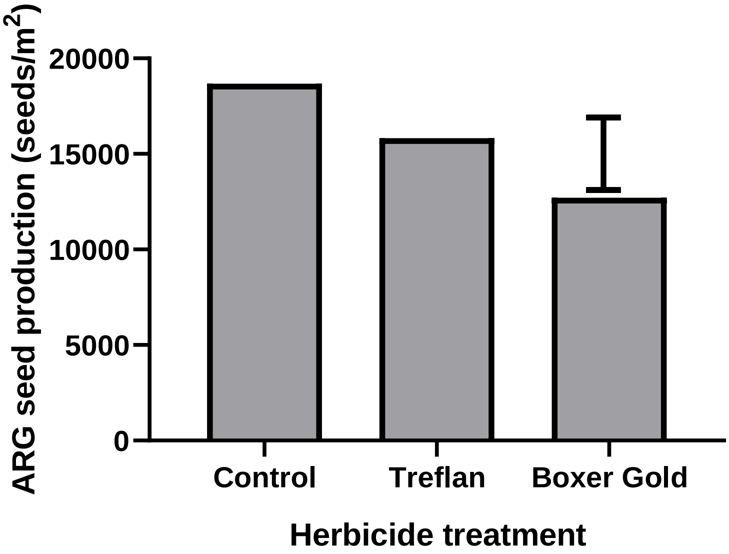

Figure 5. The effect of herbicide treatments (averaged across sowing times and seed rates) on ryegrass seed production. The vertical bar represents LSD (P=0.05).

Barley grain yield

Barley grain yield as significantly influenced by the time of sowing (P=0.025), seed rate (P<0.001) and the herbicide treatment (P<0.001). The delay of 4 weeks between the two sowing dates caused 22% (0.69 t/ha) reduction in grain yield or 25 kg/ha/day. In all the herbicide treatments, delay in sowing reduced barley grass yield by 21-23%. Averaged over the two sowing dates and three seed rates, Boxer Gold treatment (2.996 t/ha) produced significantly greater barley grain yield than Treflan (2.634 t/ha) and the control (2.648 t/ha) (Figure 4).

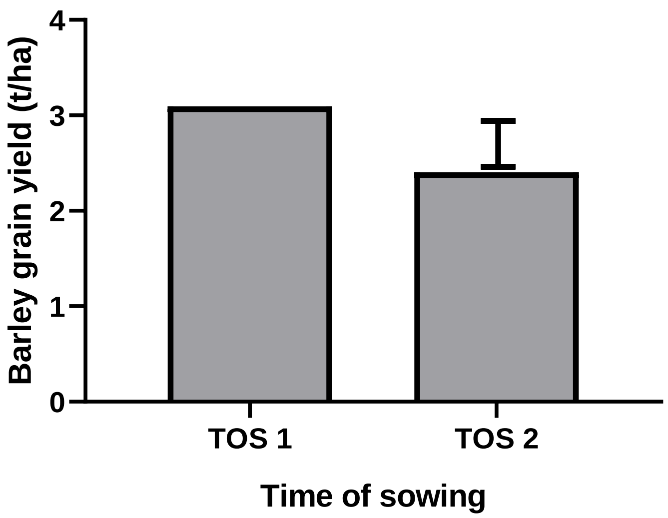

Figure 3. Effect of time of sowing on barley grain yield. The vertical bar represents LSD (P=0.05).

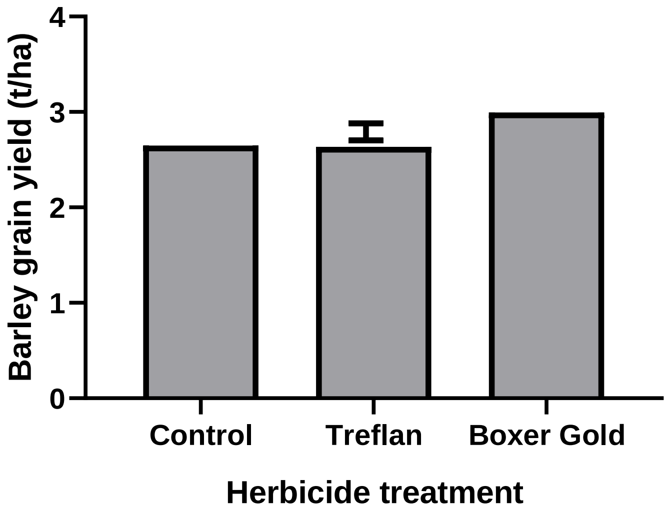

Figure 4. Effect of herbicide treatments on barley grain yield. The vertical bar represents LSD (P=0.05).